DOCUMENT RESUME

ED 318 608 SE 051 355

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TITLE Math Anxiety, Attainment of Statistical Concepts, and Expressed Preference for a Formal-Deductive Cognitive Style among Beginning Students of Research.
PUB DATE 89
NOTE 16p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (Little Rock, AR, November 10, 1989).
PUB TYPE Reports - Research/Technical (143) -- Viewpoints (120)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; Cognitive Development; *Cognitive Structures; *Cognitive Style; *College Mathematics; Higher Education; *Mathematics Anxiety; Mathematics Education; *Mathematics Tests; Test Anxiety

ABSTRACT

This study investigated the propositions that (1) the expressed preference for formal-deductive style of thinking and mathematics anxiety are negatively correlated; (2) the preferred cognitive style is positively correlated with the respondent's self-assessment of mathematical ability; and (3) those expressing a preference for the analyst style of thinking would perform better on a test of statistical concepts than those expressing a disregard for the analyst style of thinking. The sample included 70 male and female graduate students. Results indicated that the propositions were supported by the data. Implications from this research are discussed. (CW)

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Math Anxiety, Attainment of Statistical Concepts, and Expressed Preference for a Formal-Deductive Cognitive Style among Beginning Students of Research

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Descriptors:

Math Anxiety
Cognitive Style
Teaching Research

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Paper Presented at the Annual Meeting of the
Mid-South Educational Research Association
Little Rock, Arkansas
November 10, 1989

Study III of a Symposium:
"At the Interface between Personality and Cognition": A Symposium of Research into Intellectual Style As Measured by the Harrison-Bramson InQ
Organizer: Louis A. Franceschini, Memphis City Schools, Memphis, TN

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STUDY III

MATH ANXIETY, MATH ACHIEVEMENT, AND THE ANALYST STYLE OF THINKING

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INTRODUCTION

The Harrison-Bramson (1982) Inquiry Mode Questionnaire (InQ) is an index of stylistic preference rather than ability. Nevertheless, as Messick (1976) has indicated in his overview of the cognitive style literature, cognitive abilities and cognitive styles sometimes overlap. In an attempt to organize the congeries of styles empirically investigated, Kogan (1973) has imposed a classification of stylistic dimensions based on a given style's putative distance from the ability domain. Kogan called such dimensions "Type I" cognitive styles, "for performance on the operational index of the style can be described as more or less veridical" (1976, p. 5). More recently, neo-Piagetian researchers have incorporated the notion of cognitive style into stage development theory. Conceived of as mediating between genotypic endowment and phenotypic performance, cognitive style functioning as a "moderator of competence" serves the neo-Piagetians in explaining at least some of the disconfirming evidence that has of late been leveled at genetic epistemology (Neimark *et al.*, 1985).

Although Harrison and Bramson make no expressed claims of

association between a given style or styles of thinking and superior performance on a range of specific abilities, characteristics associated with each of the five thinking styles would seem to inspire inference and invite investigation. While many research avenues presented themselves, the ostensive formal-deductive character of the Analyst style of thinking, coupled with Harrison and Bramson's (1982) own direct admonition that the low Analyst "study statistics or Operations Research," suggested that further study of the relationships between preference for Analyst style of thinking, degree of math anxiety, self-assessed mathematical ability, and scores on a test of mathematical ability might be the best first route to pursue.

RESEARCH QUESTIONS:

Specific propositions under test in the study were as follows:

1) that expressed preference for a formal-deductive style of thinking as measured by the InQ and math anxiety as measured by the Aiken-Draeger scale of math anxiety would be significantly negatively correlated;

2) that expressed preference for a formal-deductive style of thinking as measured by the InQ and the respondent's self-assessment of his

or her own mathematical ability (measured on a scale of 1-9) would be significantly positively correlated; and

3) that those expressing a significant preference for the Analyst style of thinking would perform significantly better on a test of statistical concepts than those expressing a significant disregard for the Analyst style of thinking--where "significant preference" is an InQ score of 60 or above, and "significant disregard" is an InQ score of 48 or below.

THE SAMPLE IN CONTEXT

The respondents in the study were seventy male and female graduate students enrolled in two introductory classes in educational research during the university's summer semester. All of the respondents were taught by the same professor with the same syllabus, using the same materials. The Harrison-Bramson InQ was introduced early in the term in a discussion of forms of inquiry in social research. After the instruments were administered and scored, student profiles were interpreted for the class, and raw scores on the Synthesist and Realist InQ styles were plotted against each other to demonstrate the concepts of covariation and correlation. At no time, however, was mention made of the researchers'

"darker purpose" so as to avoid the possibility of biasing responses or performance on any of the other measures.

Shortly before their first examination and following the completion of a first instructional module on statistics, the respondents were administered the Aiken-Draeger Math Anxiety Scale without much ceremony, other than to offer the twenty-item instrument as an example of a Likert-type scale. Appended to the scale were two additional questions asking for a single number to "fill in the blank." The respondents were asked 1) to rate themselves as mathematics students on a scale from 1 to 9, where a response of 1 meant very poor and 9 meant superior; and b) to estimate the number of math-oriented courses the respondent had completed (excluding the research course itself) within the preceding five years. While no relationship was anticipated (nor later found) between scores on the Analyst style and number of math courses completed, it was felt that the information might be useful should great disparities in prior knowledge among respondents act so as to significantly desensitize the analysis. Several days following the administration of this instrument, the respondents took their first statistics test on measures of central tendency and variability.

RESULTS

Unsurprisingly, all three propositions stood up to the test. High scores on the two more "abstract" styles of thinking--Synthesist and Analyst--were both significantly associated with low scores on math anxiety, and conversely (for the full correlation matrix, see Table 1). Specifically, Analyst scores correlated significantly negatively with math anxiety scores ($r = -0.38$, $p = 0.0013$), significantly positively with self-assessed mathematics ability ($r = 0.32$, $p = .0069$), and significantly positively with the classroom statistics test ($r = .28$, $p = .019$).

The lower correlation observed for Analyst scores and the statistics test is perhaps better understood in the ANOVA context (see Table 2). Breaking the sample into three groups according to Harrison and Bramson's own scheme of interpretation--low Analyst denoted by a score less than or equal to 48, no preference for the Analyst style denoted by a score between 49 and 59 inclusive, and high Analyst denoted by a score greater than or equal to 60)--we found that it was the performance of the "no preference" group that decreased the index of linear relationship. Depending on any number of other factors exogeneous to the study (interest, native ability, time available for study), a respondent in the no preference group may have done very well or very poorly. Clearly, though,

as Table 2 shows, high Analysts have a decided "edge" over low Analysts--better than a 10 point edge by our reckoning here--in a beginning research/statistics class, all other things being equal.

Moreover, our surmise is that the size of that "edge" and the magnitude of the absolute correlations are both higher than observed here, because of factors in the study beyond our control. As a rule, the professor teaching the course allows students with prior training to absent themselves from class when the statistical module of the course is taught. Because we do not have math anxiety and InQ scores on those individuals, they are unfortunately not in the sample. Yet given the behavioral cues associated with the Analyst thinking style, coupled with our own knowledge of these students and their subsequent performance in the course, our supposition is that the inter-relationships between measures of cognitive style, math anxiety, and self-assessed mathematics ability are perhaps much stronger than indicated here.

Two unexpected findings emerging from the study are also noteworthy: the significantly negative correlation between the Synthesist style of thinking and measurable mathematics anxiety ($r = -0.31$, $p = .0101$) and the sheer magnitude of the relationship between mathematics anxiety and self-assessed mathematics ability ($r = -0.81$, $p = .0001$). That the

Synthesist may not "fear" math is understandable given the alleged "abstract" orientation of the style. Moreover, that the Synthesist may not particularly excel at mathematics is likewise understandable given that the interests of the Synthesist are galvanized less by methods and formulae than by theories and the unformulated. For such an individual, mathematics may be too cut and dried, too pat, in some sense, too simpleminded to give us any genuine purchase on the obvious complexity that surrounds us.

The correlation coefficient of .81 ($p < .001$) between mathematics anxiety and self-assessed mathematics ability would seem to indicate that while the math anxious individual may not know math, he or she certainly knows his or her own mind--that expectations recede linearly as tensions mount. With a robustness that is seldom seen in the behavioral sciences (Kerlinger, 1986), the strength of the association might lead us to wonder whether math anxiety instruments are really necessary when a single well-timed question may reveal as much.

DISCUSSION

In one way or another, gender has been the regnant issue in math anxiety research and continues to be so despite Aiken's (1976) call for

"multivariate approaches" to the subject and Tobias's (1978) avowal that, although she had once "hypothesized that mathematics anxiety and mathematics avoidance were feminist issues," she was now beginning to back away from her original formulation: "Now I am not so sure. Observing men has shown me that some men as well as the majority of women have been denied the pleasures and the power that competence in math and science can provide" (p. 5). Compare also Tobias (1976) and Campbell (1986).

According to the InQ literature, styles of thinking do not appear to be gender-related, although it seems reasonable that if social expectations militate against an individual's adoption of a given style, that particular style will not develop. Hence, a dynamic akin to Gregory Bateson's (1975) "cybernetics of drunkenness" might ensue. Thrown into a situation (a mathematics class) where use of a particular style (the Analyst style) is perhaps the single most important key to success, the individual will find him or herself one-down and less likely to succeed. In distress, then, the individual continues to avoid such situations and therefore continues to underuse the style. Underuse of the style again brings reduced chances of success at the next forced encounter; and so, convinced that history doesn't lie, the individual resolves to "bite the bullet," give it everything

he/she's got (save the one thing needed), and try again--with diminished and ever more diminishing expectations of "ever understanding the stuff."

If berating a drunkard for drunkenness only seems to make the drinker drink more, then obviously other interventions are called for to enable the individual to break the cycle of defeat. Recognizing that individuals differ in cognitive style and acting on those recognitions--perhaps in ways that several in the literature have suggested (Hanna, Hill, and Ordway, 1988; Quilter and Harper, 1988)--might be a significant first step in reducing math anxiety and improving mathematics achievement.

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Table 1

Intercorrelations among Scales and Subscales

Scale or Subscale	1	2	3	4	5	6	7	8
				Entire Sample (n = 70)				
1. Aiken Scale	1	-0.81	-0.46	-0.31	0.33	0.29	-0.38	0.28
p =	0.0	.0001	.0001	.01	.01	.01	.001	.02
2. Self-Assess Ability		1	0.39	0.22	-0.10	-0.26	0.32	-0.31
p =		0.0	.001	.06	.39	.03	.01	.01
3. Stat Test Score			1	0.16	-0.07	-0.24	0.28	-0.23
p =			0.0	.19	.55	.04	.02	.06
4. Synthesist				1	-0.50	-0.24	-0.07	-0.70
p =				0.0	.0001	.04	.54	.0001
5. Idealist					1	-0.13	-0.10	0.12
p =					0.0	.30	.39	.34
6. Pragmatist						1	-0.65	0.20
p =						0.0	.0001	.09
7. Analyst							1	-0.25
p =							0.0	.03
8. Realist								1
p =								0.0

Table 2

Analysis of Variance (ANOVA) among Analyst Subgroups and Total Sample for the Statistics Test Score, including Sample and Subgroup Means and Standard Deviations

Source	DF	SS	MS	F	p <
Subgroups	2	830.195	415.097	3.30	.04
Error	67	8426.677	125.771		
Total	69	9256.871			

Group Comparisons for Differences between Means:

Analyst - No Preference	6.013
Analyst - Non-Analyst	10.233*
No Preference - Non-Analyst	4.221

* $p < .05$

Total Sample Descriptive Statistics:

Scale/subscale	Mean	S.D.
Entire Sample (n = 70)		
1. Aiken Math Anxiety Scale	64.243	22.360
2. Self-Assessed Ability	4.929	2.087
3. Statistics Test Score	73.957	11.583
4. Synthesist	46.243	9.541
5. Idealist	55.571	5.544
6. Pragmatist	54.900	6.361
7. Analyst	54.200	7.131
8. Realist	59.043	6.643

(continued)

Table 2 (continued)

Analyst Subgroup Descriptive Statistics:		
Scale/subscale	Mean	S.D.
Non-Analyst (n = 15)		
1. Aiken Math Anxiety Scale	69.400	20.518
2. Self-Assessed Ability	4.333	1.877
3. Statistics Test Score	69.267	13.117
4. Synthesist	51.200	11.409
5. Idealist	53.600	5.152
6. Pragmatist	59.600	5.289
7. Analyst	45.667	3.086
8. Realist	59.933	7.648
Analyst-No Preference (n = 39)		
1. Aiken Math Anxiety Scale	68.821	21.689
2. Self-Assessed Ability	4.641	2.158
3. Statistics Test Score	73.487	11.116
4. Synthesist	43.590	7.486
5. Idealist	57.436	5.651
6. Pragmatist	55.282	5.808
7. Analyst	53.205	3.155
8. Realist	60.359	5.664
Analyst (n = 16)		
1. Aiken Math Anxiety Scale	48.250	19.011
2. Self-Assessed Ability	6.188	1.642
3. Statistics Test Score	79.500	9.388
4. Synthesist	48.063	10.434
5. Idealist	52.875	3.879
6. Pragmatist	49.563	4.661
7. Analyst	64.625	2.918
8. Realist	55.000	6.663